# Mars 2020: Perseverance Rover Mission Description

## Mission Overview

The goals of the Mars 2020 mission are to seek signs of life and to collect rock and soil samples for a possible future return to Earth. The Perseverance Rover explores the landing site and acquires imaging, spectroscopy, and other measurements to characterize Martian soils, rocks, atmosphere, and other aspects of the environment. Perseverance carries seven scientific instruments and a sample acquisition and caching system. The various payload elements are used as an integrated suite of tools to characterize the local geology, to study particular rock and soil targets, to characterize the local environment, and to acquire and cache selected rock and soil samples. The prime mission for the rover is expected to be 836 sols (approximately 2.5 Earth years), with the possibility of an extended mission of unknown duration after that.

The seven science instruments can be classified into the following groups. Table 1 lists key aspects of each science investigation.

*Remote sensing:* Mounted on the top of a mast are the Mastcam-Z multispectral, stereoscopic imaging system with zoom capability provided by Arizona State University (PI: James Bell); SuperCam, a suite of six instruments in one including a laser-induced breakdown spectrometer, Raman spectrometer, Time-Resolved Fluorescence spectrometer, visible and infrared spectrometer, remote micro-imager, and microphone provided by Los Alamos National Laboratory (PI: Roger Wiens); and mounted on the body of the rover is RIMFAX, a ground-penetrating radar (GPR) provided by Forsvarets Forskning Institute (FFI), Norway (PI: Svein-Erik Hamran).

*Proximity science:* On the end of the robotic arm are PIXL, a microfocus X-ray fluorescence instrument provided by the Jet Propulsion Laboratory (PI: Abigail Allwood), and SHERLOC, Deep UV (DUV) resonance Raman and fluorescence spectrometer provided by the Jet Propulsion Laboratory (PI: Luther Beegle).

Both proximity science instruments have mapping capabilities supported by their own integrated imagers. In addition, SHERLOC includes a second imager (WATSON) to be used for science and engineering purposes with high spatial resolution, color, and infinity focus.

*Environmental measurements:* Mounted on the mast is MEDA, a meteorology package provided by the Centro de Astrobiología/ Instituto Nacional de Tecnica Aeroespacial (PI: José Antonio Rodríguez-Manfredi).

*In-situ resource utilization:* Mounted on the rover body is MOXIE, a demonstration of In-Situ Resource Utilization (ISRU) technologies provided by the Massachusetts Institute of Technology (MIT) (PI: Michael Hecht).

*Technology demonstration:* The Mars 2020 rover carries a helicopter as a technology demonstration. The helicopter will fly up to 5 times over a ~30 sol period early in the mission. The helicopter carries two cameras, one for navigation and one for capturing aerial views for science evaluation. The images are stored onboard during flight, and then are transmitted to the rover afterwards for relay to Earth.

Table 1. Key Aspects of the Perseverance Payload

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| Investigation | Key Parameters | Science Measurements |
| Mastcam-Z | Mastcam-Z consists of two matched cameras, Mastcam-  Left and Mastcam-Right with a 3.6:1 zoom range (28mm  to 100mm). Both have an integrated RGB Bayer pattern  filter integrated over their detector for natural color plus  narrow-band filters (430-1085nm range) for scientific  color. 1600 × 1200 pixel images. At the narrowest field of  view (100mm), the cameras have 7.4 cm/pixel scale at 1  km distance and ~150 μm/pixel scale at 2 m distance. At  the widest field of view (28mm), the cameras have a 532  μm/pixel scale at 2 m distance and 27 cm/pixel at 1 km.  HD video at ~4 frames per second, 1280 × 720 pixels. | Observations of geologic  structures and features.  Studies of landscape, rocks,  fines, soils, frost/ice, and  atmospheric features. |
| SuperCam  (remote-  sensing composition  and high-resolution  imaging) | Laser-induced breakdown spectroscopy (LIBS)  measurements made from a distance of up to 7 meters;  240-850 nm spectral range, 14-bit dynamic resolution  over 8194 channels.  Dust removal over a ~1 cm diameter region.  Raman spectroscopy measurements made from a  distance of up to 12 meters; 150-4400 cm-1 spectral  range at better than 10 cm-1 resolution;  Time-resolved fluorescence with better than 25 ns  adjustable time resolution.  High-resolution color context imaging with a > 15 mrad  field of view and < 0.020 mrad pixel resolution.  Microphone to measure the pressure wave produced by  the generation of plasma at a LIBS target. | Rapid chemical and  mineralogical composition of  rocks and soils and high-  resolution color imaging  from a distance. |
| Hazcams  (Hazard  Cameras) | Color stereo imaging in front of rover and rear of rover,  0.4 mrad IFOV, 90°x120° FOV; 5120x3840 pixel images. | Imaging used for hazard  avoidance during traverses  and robotic arm deployment  support. Also useful as  science imaging of rocks and  soils, targeted remote  sensing |
| Helicopter | Navcam: 640x480 pixel 8-bit grayscale images pointing  straight down from the belly of the helicopter.  Return to Earth camera: 4224x3120 pixel 8-bit color  images. Mounted on the side of the helicopter facing  downward at an angle to see both nadir and horizon. | Imaging used by onboard  navigation software to  determine helicopter  position and attitude and to  help navigate. |
| Navcams  (Navigation  Cameras) | Color stereo imaging on Remote Sensing Mast (RSM), 360  degree azimuthal field of regard, +/90 degrees elevation,  0.3 mrad IFOV, 70°x90° FOV; 5120x3840 pixel images. | Imaging used for planning  rover traverses and targeted  remote sensing. Also useful  as science imaging of  geologic structures and  features, rocks, and soils. |
| PIXL  (Planetary  Instrument for X-ray  Lithochemistry) | Microfocus X-ray fluorescence (XRF) spectroscopy using a  Rh X-ray tube, a polycapillary focusing optic, and energy-  dispersive Silicon Drift Detectors (SDD) to provide an X-  ray spectral range from <1 keV to 28 keV. Measures  abundances of 23 elements with a spatial resolution of  125 um at a distance of 3 cm. Micro-context camera  images register element distributions to visual features. | Abundances and sub-  millimeter-scale distribution  of elements in relation to  rock/soil texture and  microstructure. |
| SHERLOC  (Scanning  Habitable  Environments with  Raman and  Luminescence for  Organics and  Chemicals) | Laser Raman spectroscopy and imaging measurements  taken from a distance of ~30 mm. 50 um beam diameter,  30 um depth of penetration, 7 f-number collection  aperture. Single in-focus 2D, 11 bit context-imaging. DUV  fluorescence/Raman spectra from an average over 49, 1 x  1 mm areas over a 7 x 7 mm FOV. 2048 x 1 pixel data  products for each point of a 400 point 50 μm/pixel map  over a nominal 1 x 1 mm surface. | Non-contact, spatially  resolved, and highly  sensitivity detection and  characterization of organics  and minerals in the Martian  surface and near subsurface. |
| MOXIE  (Mars Oxygen  In-Situ Resource  Utilization  Experiment) | Technology Demonstration: In situ resource utilization of  Martian atmospheric CO 2, which is collected and  delivered at 1 atm of pressure to a solid oxide electrolyzer  operating at 800 °C that electrochemically generates O2 .  The science measurements will characterize MOXIE  performance on Mars to inform next generation, scaled  up designs. | Effluent waste and product  stream composition to  determine oxygen  production rate and purity;  CO 2 flow rate; and  temperature, voltage and  current of the electrolyzer. |
| MEDA  (Mars Environmental  Dynamics Analyzer) | Variable sampling rate acquisitions (max 2Hz) at regular  intervals of:  Air temperature (range 150K-300K).  Pressure (1-1200Pa).  Humidity (1-100% RH).  Vertical and 2-D horizontal wind speed (0-70m/s).  Downward sky IR radiation (bands 6-35,14.5-15.5  microns, overall temp range 173K-293K) and upward  surface IR radiation (6-35, 8-14, 16-20 microns, target  temp range 173K-293K).  Downward sky irradiance fluxes in 8 bands (255, 295, 250-  400, 450, 650, 880, 950, 190-1100 nm), and side-pointing  photodetectors (880 nm and 27.5 deg. above the deck).  Upward pointing CCD sensor with a +/- 60 degrees FOV  around zenith. | Characterization of near-  surface optical opacity and  angular scattering properties  of atmospheric aerosols  (special emphasis on  atmospheric dust size and  morphology), as well as  thermal response of  atmosphere, radiative and  convective forcing of surface  and atmosphere, surface  pressure cycle, water cycle  and wind speed and  direction |
| RIMFAX (Ground  Penetrating Radar,  mounted on back of  rover) | Gated Frequency Modulated Continuous Wave Radar  (150 MHz – 1200 MHz frequency range) | Subsurface radar profiles  measured every 10 cm along  rover track, with vertical  resolution of <30 cm and  penetration depths of more  than 10 meters depending  on materials |
| Returned Sample  Science | Time, rover location and orientation, site information,  sample drill location, other parameters associated with  drilling, final sample cache location, tracking information  including sample collection plans and uplinked sequences  (e.g. documentation of why this target was drilled). | Observations that provide  context for sample  collection, including before  and after images, other data  that document the drill  target and cache location,  including remote sensing  data |

## Mission Phases

Launch

Target Name : MARS

Mission Phase Start Time : 2020-07-30

Mission Phase Stop Time : 2020-07-30

Spacecraft Operations Type : ROVER

Cruise

Target Name : MARS

Mission Phase Start Time : 2020-07-30

Mission Phase Stop Time : 2020-12

Spacecraft Operations Type : ROVER

Approach

Target Name : MARS

Mission Phase Start Time : 2020-12

Mission Phase Stop Time : 2021-02-18

Spacecraft Operations Type : ROVER

Entry, Descent, and Landing

Target Name : MARS

Mission Phase Start Time : 2021-02-18

Mission Phase Stop Time : 2021-02-18

Spacecraft Operations Type : ROVER

Prime Mission

Target Name : MARS

Mission Phase Start Time : 2021-02-18

Mission Phase Stop Time : 2023-01-06

Spacecraft Operations Type : ROVER

Extended Mission 1

Target Name : MARS

Mission Phase Start Time : 2023-01-06

Mission Phase Stop Time : PRESENT

Spacecraft Operations Type : ROVER

Relevant References

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